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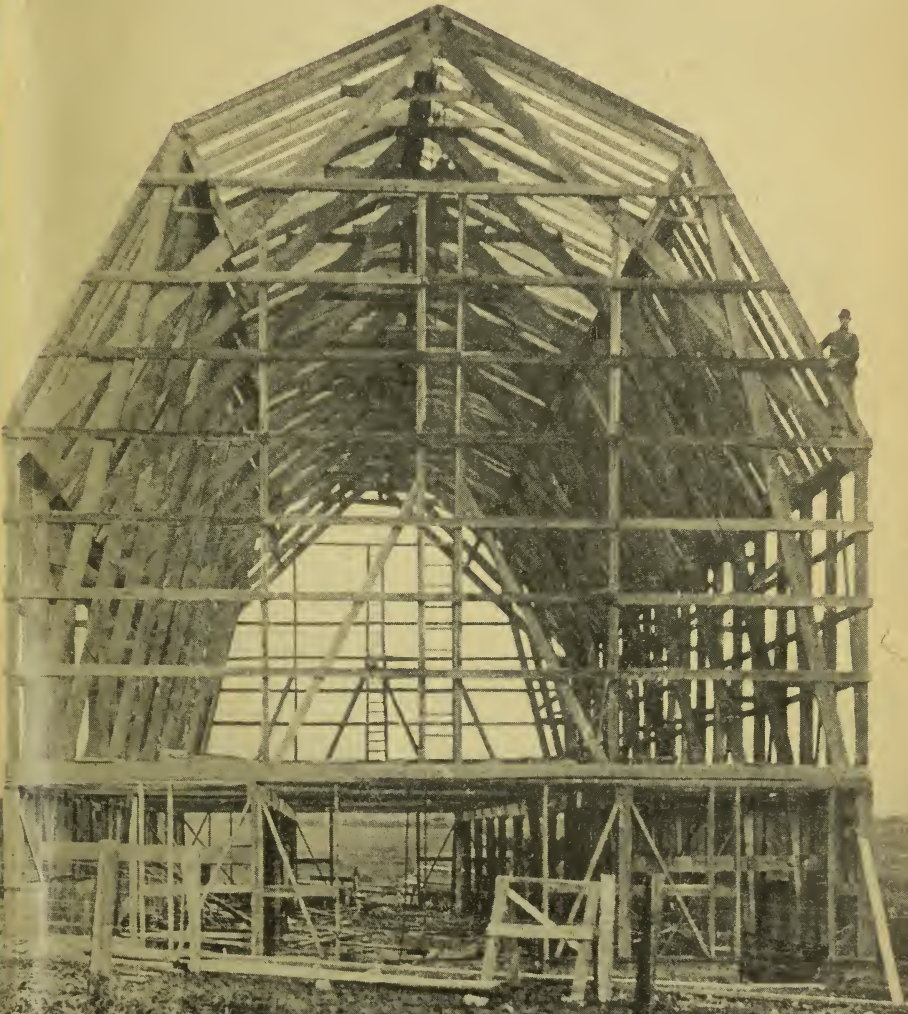
Dairy Barns



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DIGEST

Build from a plan. The best results from building can be had only by planning the structure before laying the foundation. Pages 3–6

Direct sunlight is a good disinfectant, and should be used to the utmost. Square projections of walls at the sides and bottom of a window cut off much direct sunlight. Windows should be as near the outside of the wall as practicable. Pages 6–7

A ventilation system is necessary if animals are to be kept in good condition. The King system (after Prof. F. H. King) is satisfactory for Wisconsin conditions. Good ventilation depends on having air flues of the proper size, arrangement, and construction. Pages 7–14

A well drained site for the barn is essential. A barn with its longer dimension north and south receives the most sunlight in the forenoon and late afternoon. An east and west position allows the absorption of the most sunlight during the middle of the day when direct sunlight is most effective. Pages 14–16

The size of barn to build does not depend upon the size of the farm, but upon local conditions. Page 16

The rectangular barn with a gambrel roof is the most popular in Wisconsin. An outside width of 36 feet accommodates two rows of stanchions. Cows may be arranged either "heads together" or "tails together." Gambrel roofs of the plank frame or braced rafter type or the Gothic roofs are self supporting and will allow more mow capacity than do the gable roofs. Pages 17–23

The settler's barn must be of a different type from the structure planned for an improved farm. Hewn timber and other materials at hand can be used with advantage. The barn plan should allow for future additions. Pages 27–30

Remodeling the old barn is often necessary on many farms. In some cases only the inside needs changing and new equipment. In others, additions may be built with advantage. Pages 27–30

The milk house belongs outside the barn. The equipment depends on the form in which the produce is marketed. Page 30

Plans for farm buildings and equipment may be had from the Agricultural Experiment Station, Madison. Page 34

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Dairy Barns

O. R. ZEASMAN, G. C. HUMPHREY AND L. M. SCHINDLER

A barn for Wisconsin's climate must be warm, well lighted, and properly ventilated. Cows quartered in a warm barn require less feed and produce more milk. Money spent for inside sheathing, building paper, and other insulating material is well invested. Abundant sunlight and proper ventilation are needed to keep the livestock healthy. Heat is wasted and poor circulation results when windows and hay chutes are used for ventilation in the winter time.

Wisconsin's reputation for good dairy cattle brings many buyers for such stock from outside the state. These buyers, in selecting healthy cattle, place much stress upon the kind and condition of buildings in which the stock was raised. Good barns always add more value than their cost to the market price of the farm.

BUILD FROM A PLAN

A conveniently arranged barn saves labor in doing chores. A careful study of a proposed barn plan often shows how minor changes in the placing of the stalls or the position of the feed room or silo will effect a big saving in labor. Changes are often difficult and always more costly to make after the barn is built. A plan gives the owner a picture of his barn before building starts and allows him to make changes. Workmen make fewer mistakes and put up a better barn if they are required to follow a good plan rather than to work out the construction and arrangement haphazardly.

THE RIGHT BARN FOR THE RIGHT FARM

The size, arrangement, and storage capacity of a dairy barn depend upon local conditions and the methods of the manager.

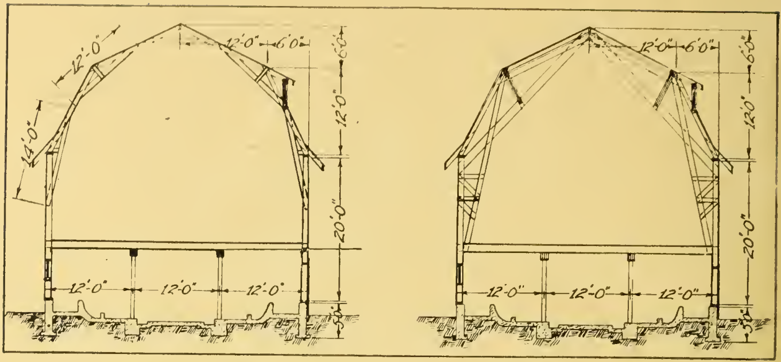


FIG. 1.—(A) BRACED RAFTER FRAMING

Five braces are spiked to each set of rafters. Short stock lengths of lumber are used for the entire frame.

(B) PLANK FRAME CONSTRUCTION

Trusses spaced 12 or 14 feet apart support the roof. Rafters between trusses are not braced but are spiked to a purlin plate.

The right barn for one farm may not be the right barn for another farm of the same size. Sometimes not more than eight or ten cows are kept on a 200 acre farm, while twice as many dairy cows are often found on a 40 acre farm. The fertility of the soil, local market prices, cost of commercial feeds, and the interest of the owner will all affect the type of farming

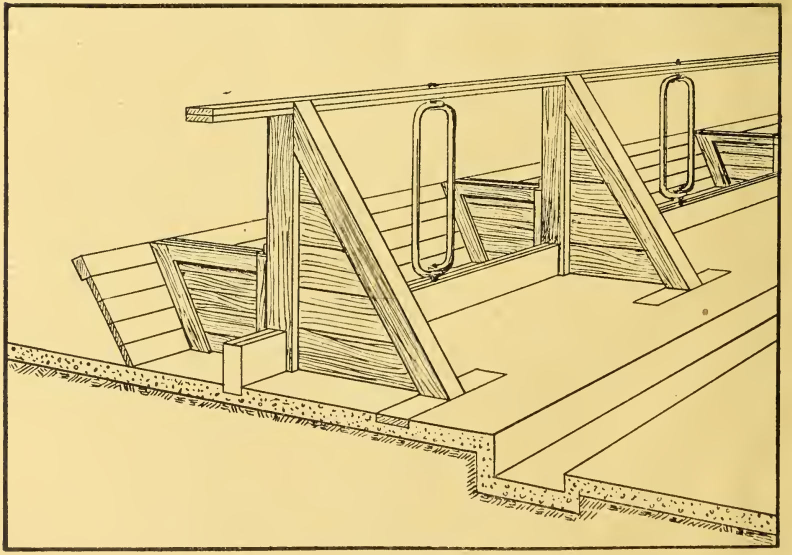


FIG. 2.—HOMEMADE BUT PRACTICAL

This stall can be built by farm labor. Stall floor and manger are easily cleaned.

followed. This will determine the size and arrangement of the barn. Attempts to develop model standard barn plans for farms of a given size, therefore, meet with little success. The owner can best make a suitable choice after studying local conditions.

Certain features of building, however, have become standardized. The construction used for two of the most common types of framing—the plank truss and braced rafter types (Fig. 1)—has been quite commonly adopted. The Gothic roof barn (Fig. 16) is a recent feature that is gaining favor. Standard dimensions for stalls, mangers and gutters are also desirable.

Labor-saving devices such as litter carriers, feed carriers, or feed trucks are worth having. Home-made devices may often be used advantageously. Figure 2 suggests a home-made cow stall and manger, with an adjustable metal stanchion. The manger is built in sections, three or four stalls wide, and is hinged at the top to permit raising it for cleaning.

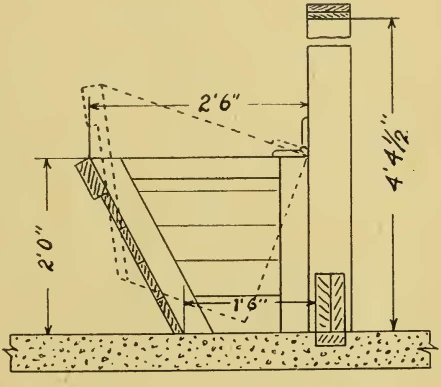


FIG. 3.—MANGER CONSTRUCTION

A movable manger has some advantages.

Provide Box Stalls

A bull pen and one or more calving stalls are needed on a dairy or stock farm. Proper care of dairy cows requires at least one maternity stall for every 12 to 14 cows. These stalls should be about 8 x 12 feet. The size of the calf pen depends on the number of calves to be raised. Its smallest dimension, however, should be not less than 7 feet. A row of stanchions on one side, along an aisle, is handy for feeding. A box stall, about 12 x 12 feet is often provided for the bull, or a single stall may be used. A convenient arrangement for the bull stall is shown in figure 4. It provides for two outside doors, one for the bull to enter, the other to go out. Such an arrangement makes it unnecessary for the attendant to enter the stall. The exit door can be opened from the outside, the bull untied from the front and allowed to go out and exercise. This plan prevents the bull from turning around; and there is no necessity for getting into the stall either to turn him out or to tie him.

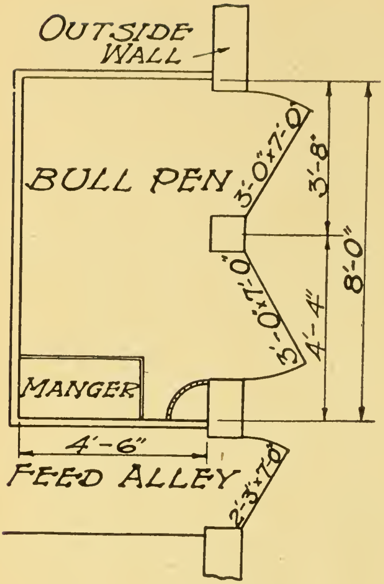


FIG. 4.—SAFETY FIRST

This pen is so arranged that the attendant can care for the bull without entering the stall.

SUNLIGHT A GOOD DISINFECTANT

Direct sunlight should be used to the utmost. A well-lighted barn is more easily kept sanitary. Bank barns are dark and damp and have only one good feature—a direct drive to the second floor. This may be had without sacrificing light on one side of the barn by

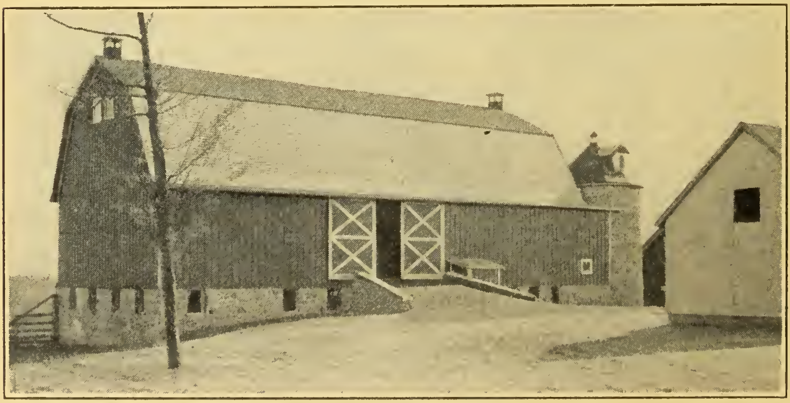


FIG. 5.—DRIVEWAY TO THE MOW

This arrangement has all the advantages of a bank barn and allows light and fresh air to enter the barn from all sides.

the use of an incline drive (Fig. 5). A bridge, as suggested, permits placing windows and intakes for ventilation on the four sides of the stable.

An allowance of one square foot of window area (glass area) to 20 square feet of floor area is advisable. Wide windows, well placed near the outside wall and without projections at the sides and bottom of the opening, are necessary for good lighting of the barn.

WHICH WAY SHALL THE BARN FACE?

Barns are usually placed with their length either east and west or north and south. Since each way has certain advantages, dairymen disagree as to which is the better. During the early forenoon and late afternoon when the sunlight enters a barn in the north and south position, the rays of sunlight are so indirect that it is not very effective as a disinfectant. A barn placed east and west can receive direct sunlight through about 12 windows during the noon period when the sunlight is most intense. The north and south arrangement allows only a few windows to receive direct sunlight at the noon hour, but it does permit more windows to receive direct sunlight during the day, and the sunlight reaches more of the interior of the barn. The east and west barn protects the feed lot better from the north wind; while the north and south barn affords better protection from the west wind. Considering the advantages from the viewpoint of lighting, it is best to place the barn with the long axis east and west. Other factors such as exposure, location of yards, etc., occasionally make it desirable to place the barn with the long axis north and south.

FRESH AIR SAVES FEED

Dairy cows produce more milk and make more economical use of feed when given an abundance of fresh air. Cows housed in a well ventilated barn are better able to resist infection because the number of germs in the air is greatly reduced. A good ventilation system helps to keep the temperature more nearly uniform. In Wisconsin, where it is necessary to keep livestock under shelter for several months each year, a system of ventilation to provide fresh air without cooling the barn below a desirable stable temperature is essential. The King system of ventilation was devised by the late F. H. King of the Wisconsin Experiment Station. This system is very satisfactory for Wisconsin conditions and is recommended by nearly all architects and manufacturers of barn equipment in Wisconsin and adjoining states. No individual nor corporation has any patent rights to limit or prevent the general use of the King system of ventilation.

The efficiency of the King system depends upon the location, size, and construction of the intake flues and outlet flues. Non-conducting walls and ceiling, and good tight doors and windows are essential. As in any natural or automatic system of ventilation, no provision can be made to warm the incoming fresh air except by the heat supplied from the bodies of the animals. The fresh air is warmed by mixing it with the warm air of the barn at the ceiling.

ARRANGEMENT AND CONSTRUCTION OF FLUES

The fresh air intakes are located from 10 to 15 feet apart along the barn wall. The air enters the stable at the ceiling (See B. Fig 6) where it mixes with the warm air before reaching the stock. The outside opening of the flue at A is placed at least 4 feet below B in order to prevent back draft. Where back drafts are likely to occur it is necessary to have this upright portion of the flue 6 feet long to trap the warm air effectively. Back draft is most likely to occur in flues near corners of a barn when a strong wind blows around the corners of the barn in a direction which causes an eddy or suction at the opening of an intake. The inside wall of the flue is in-

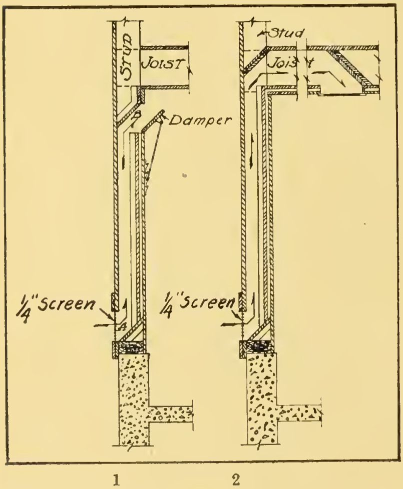


FIG. 6.—KING INTAKE IN FRAME WALL

1. The amount of air entering the barn is controlled by an adjustable damper.
2. Modified King intake in frame wall. This arrangement brings the fresh air to the center of the barn.

sulated with two thicknesses of boards, one thickness of building paper and a ¾-inch air space. This prevents the moisture from gathering on the stable wall at this point. A ¼-inch mesh or coarser screen at A protects the flue without *materially* reducing the flow of air. Where the cows face the center of the barn, many dairymen favor the construction of the intake flue illustrated by figure 6 because the fresh air is brought to the heads of the animals. Figure 7 shows the construction of an intake flue in a 24-inch stone wall. For a 12-inch concrete wall three 6-inch tile, side by side, may be built in the wall, or a wooden form (Fig. 8) used. Chimney flue lining of the right size can often be used with advantage. A strip of woven wire fencing several inches wider than the intake, placed in the thin wall outside the intake, prevents cracking of the wall at this point. The inside wall of the flue form may be built after the wall is poured.

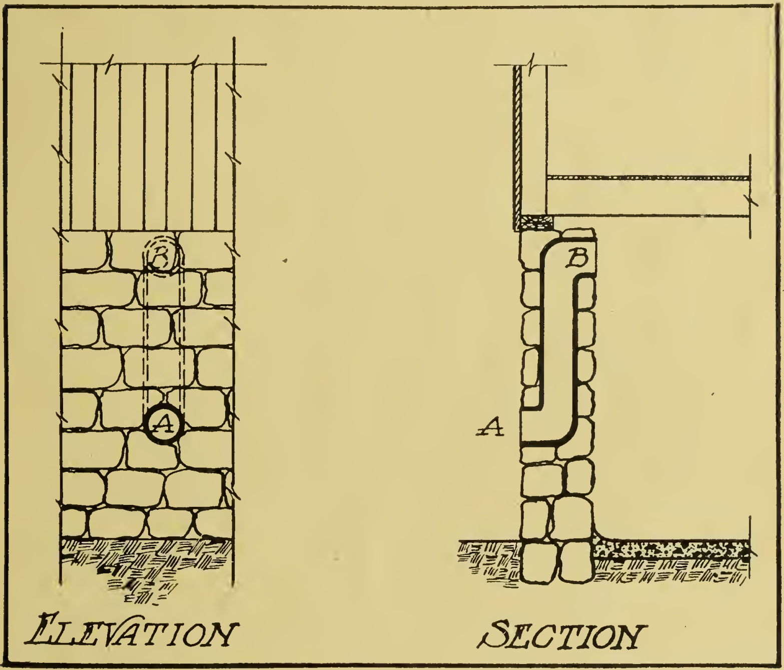


FIG. 7.—KING INTAKE IN A STONE WALL

A 10″ sewer tile forms the flue. A metal flue may be substituted for the tile.

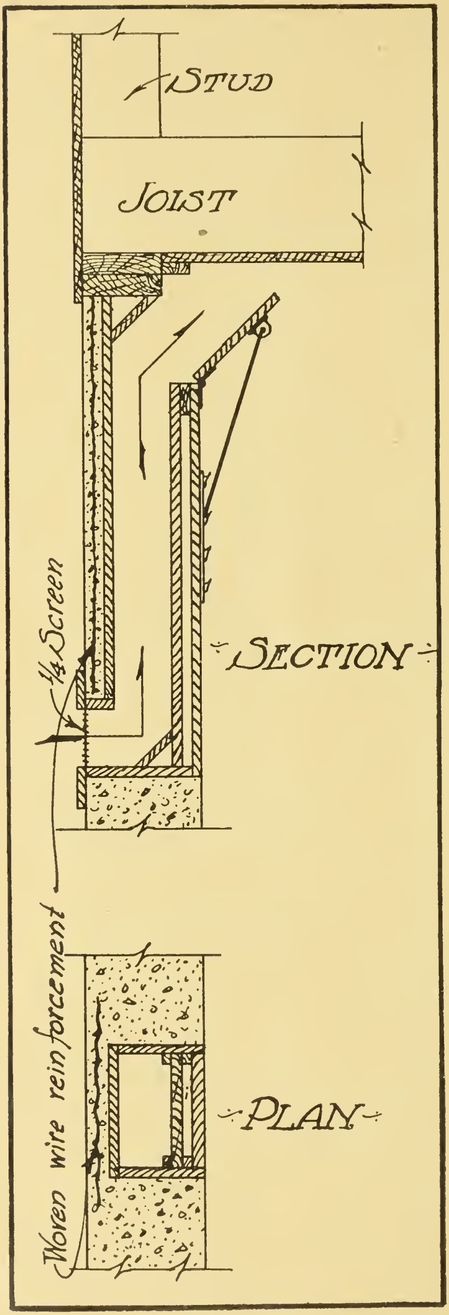


FIG. 8.—KING INTAKE IN CONCRETE WALL

The wooden form is set in place between the wall forms before the concrete is poured.

Intake flues can be added after the barn is built (Fig. 9). A hole is cut through the wall near the ceiling and a flue, closed at the sides and top, is built on the outside of the wall. This method is useful in remodeling barns but not for new ones because it is cheaper and better to build the flue in the wall when the barn is being raised.

The success of a ventilation system depends much on the outlet flues. Leaky, poorly insulated outlet flues remove little foul air from the barn and also allow moisture to condense in the flue. Water drips back into the stable from the flue and the walls remain damp. A flue built of matched lumber and building paper (Fig. 10) is practically air tight, well insulated, and gives good service. A door in the flue near the ceiling permits cooling the stable in the summer. Galvanized iron, properly insulated, may also be used in making an outlet flue. A galvanized iron or tin flue without insulation is inefficient. Abrupt bends in the outlet flue reduce the air velocity. A smooth inside wall retards the flow of air less than a rough wall. The outlet flue which reaches above the highest point of the building and other nearby obstructions uses the full force of the wind and prevents down draft.

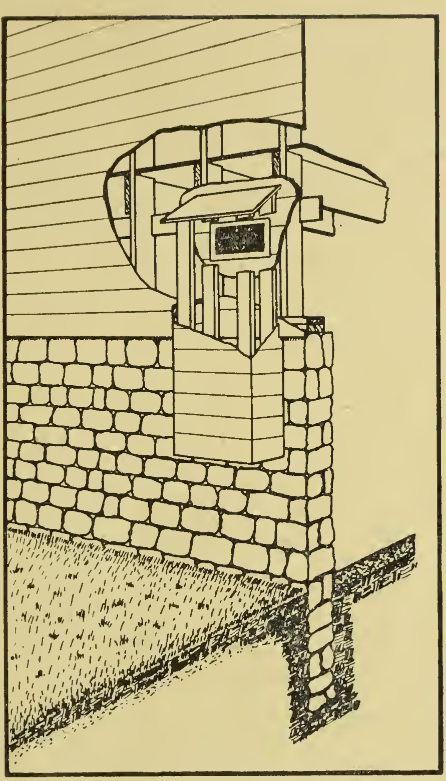


FIG. 9.—INLET FLUES ADDED TO OLD BARN

Fresh air inlet flues can be added to any barn with but little expense.

Great care must be taken in locating the outlet flues. If they are placed close to the heads of the cattle, all of the foul air will pass directly by the animals and much of it will be breathed in by them. If placed too near the entrance, the opening of the door breaks the drawing action of the flue. It is desirable to have the outlet flues out of the way and yet they should be so placed as to draw out the foul air most readily.

BUILD THE FLUES THE RIGHT SIZE

It is common practice to provide the same amount of outlet area as intake area if the barn is well built and has tight fitting doors and windows. Professor King's recommendation is: "Outlets and intakes for horses and cows should provide not less than 30 square inches a head when the outlet has a height of 30 feet; if the outlet is shorter, the area should be greater; if higher, it may be less. A 20 foot outlet flue would require about 36 square inches per head instead of 30 inches."

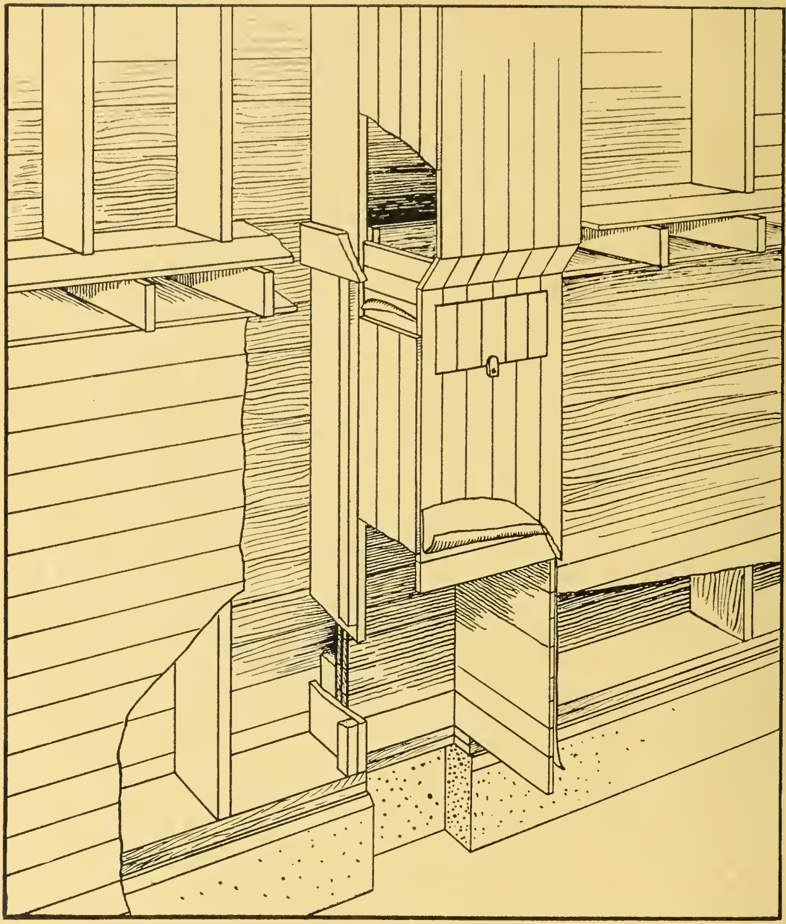


FIG. 10.—KING OUTLET FLUE IN FRAME WALL

The flue will require less space in the stable if built partially in the wall. A 2-inch air space is required between the outside sheathing and the flue.

The most practical size of intake flue is one having a cross-sectional area of 50 to 100 square inches with the outlet having 300 to 500 square inches. If a barn houses 14 cows, four horses and six calves, the number of intakes may be determined as follows. Make an allowance as for three mature head for the six calves. The stock housed would then be equivalent to 21 mature head. Assuming the outlet flue to be of the average height, the cross-sectional area of the intake flue will be 30 x 21 = 630 square inches. A 6″ x 12″ intake has an area of

72 square inches. The number of 6″ x 12″ intakes required would be $\frac{630}{72}$ or about nine. If we select an outlet 14½″ x 22″ the number of outlets required will be $\frac{630}{14\frac{1}{2}'' \times 22''}$ or about two. Nine intakes 6″ x 12″ and two outlets 14½″ x 22″ are required to ventilate this barn.

WINDOWS AND HAY CHUTES GIVE POOR VENTILATION

Open windows do not allow the definite circulation of air through the stable so necessary. for good ventilation Cross drafts are developed between windows, and much warm air from the stable escapes through the windows. Parts of the stable are poorly ventilated while the remainder is cold and drafty. If all the windows are opened the entire barn becomes too cold. Windows should be hinged (Fig. 11) so that they can be opened to cool the stable in late spring, summer, or autumn, but they are poor ventilators in winter.

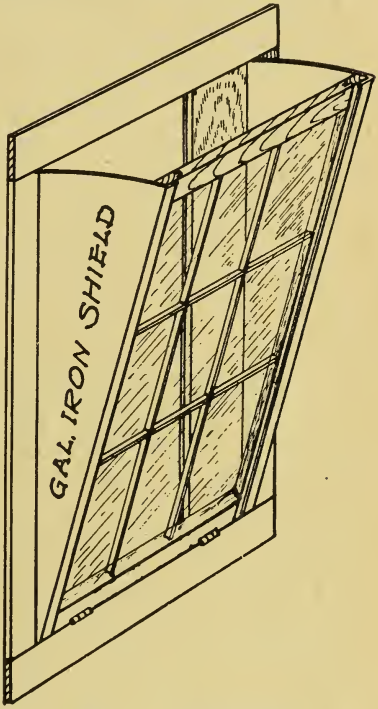


FIG. 11.—VENTILATOR

The galvanized iron shields fastened to the window frames allow the air to enter only over the top of the hinged windows. This makes possible additional ventilation without drafts.

HAY CHUTES ARE POOR OUTLET FLUES

A hay chute 3 feet square is large enough to serve as an outlet flue for 45 head of stock, but to insure the removal of foul air from all parts of the stable there should be four or five smaller flues well distributed. The usual hay chute takes all of the air from one place and is neither air tight nor well insulated. The moist air is discharged into the haymow where the moisture condenses and freezes on the hay and walls.

SUPPLYING FRESH WATER

If a water supply system is available, running water should be piped to the barn. A number of barn equipment companies manufacture automatic water systems with individual drinking cups for use in dairy barns. The advantages in the use of drinking cups are: (1) cows do not need to go into the cold for water; (2) time required for turning out cows to water is saved; (3) water is supplied to the animals at more nearly the proper temperature; and (4) water is available to each animal at all times. These factors tend to increase milk production and should be considered when buying barn equipment.

LOCATING THE BARN

Select, if possible, a site with good natural drainage. Occasionally, other factors will make it desirable to locate the barn in a position where the site or yards have poor drainage. If the wetness is due to springs or seepage water from underground, drain tile laid in the usual way is a remedy. If, on the other hand, the barnyard is on very flat ground or in a depression, surface water will not soak through the soil—which is ''puddled'' and packed by the tramping of stock—but will collect in the yard and keep it wet and insanitary. Such yards should be graded and provided with surface drainage or even covered with slabs of concrete.

The drainage of such a yard means the removal of the surface water as quickly as possible after a rain. A line of tile can be laid underground through the low part of the barnyard to an outlet into some stream, lake, or ravine. In the lowest point, or in several places, a surface inlet (Fig. 12) should be installed to allow the water to drain into the tile quickly. The cone grate prevents the entrance of straw, hay and other bulky material that might clog the drain. The down spouts from the eave troughs, overflows from watering troughs, etc., should lead underground to this drain.

To get especially clean milk extra care must be taken to make the yards sanitary. Sometimes yards are entirely covered with concrete slabs. This expense is not always justified, but under most conditions the cost of concrete approaches at the doors and gates, and slabs at watering troughs and similar places, is a small item compared with the benefits resulting.

A side hill location allowing a driveway to the second floor is a minor detail. If the barn is located on level ground, an incline can be built to the second floor by the use of an earth fill and a concrete bridge (Fig. 5). Drives are built now because farmers got the habit when lumber was cheaper, but the fact remains that drives do not make economical use of space. Such a drive is useful when one has a load of hay on the wagon during a rain storm, but several tarpaulins would do as well at a small annual cost. The large mow space, wasted by a second floor driveway, scarcely justifies the convenience.

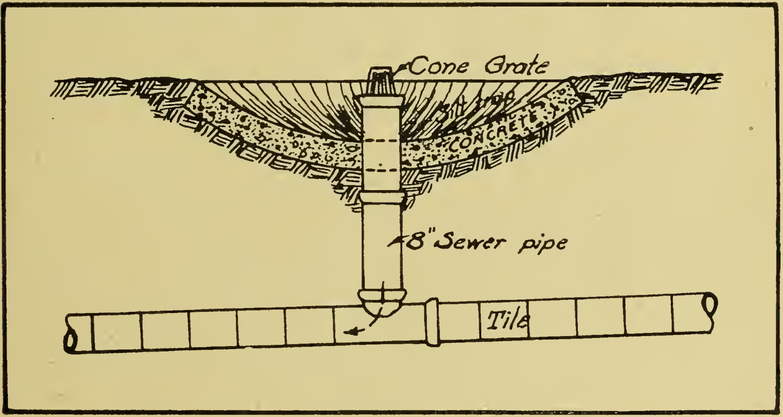


FIG. 12.—AN EFFICIENT SURFACE INTAKE.

The arrangement of the yards and fields, and the location of the well, machinery shed and granaries are factors to be considered in locating the barn. It should be at least 200 feet from the house and so placed that the prevailing winds do not carry its odors towards the house. Under the best sanitary conditions possible there will be some odor from the barn; and the time saved in going to and from the barn by having it close to the house, will not justify enduring the unpleasant odors.

The barn should not be made the most conspicuous farm building. It is secondary to the house and should be so located as not to obstruct views from the house. Usually, a location at one side and somewhat to the rear of the house will be found the most suitable.

If it is impossible to have drives leading both to the barn and to the house, the barn should be so located that either the service drive or a branch of it may be made to serve the house. This does not mean that a drive must come within a few feet of the house, as is so many times the case, but it should be convenient. It is undesirable to have the service drive for the barn, over which heavy hauling and delivery of hay and straw is to take place, close to the house. The drive may be screened by the proper planting of the lawn surrounding the house.

ONE-STORY BARN

A one-story barn with hay shed attached provides shelter for stock and storage of feed at the lowest building cost per animal. This type of barn, however, is not so warm as the two-story barn with feed stored overhead and although satisfactory as a cattle barn, it is not so popular as a dairy barn in this climate.

THE ROUND BARN

The round barn, although introduced years ago, has never gained much in favor. It has, however, these advantages:

1. The labor of feeding is reduced to a minimum.

2. More floor space can be enclosed by the same amount of wall than in any other type of barn.

3. The walls and roof of the structure are both self-bracing.

The advantages of the round barn, however, are more than offset by these disadvantages:

1. It is difficult to fill the silo because it is located in the middle of the barn.

2. The driveway takes up more space than in a rectangular barn.

3. The barn once built is a unit in itself and cannot be enlarged like the rectangular barn.

RECTANGULAR BARNS ARE MOST POPULAR

The majority of dairy barns in Wisconsin are rectangular. The best inside arrangement is one or two rows of stanchions and box stalls parallel to the long dimension of the barn. The one row arrangement requires a barn 18 to 20 feet wide while a 34 or 36 foot width accommodates two rows. For the larger herds the two row arrangement is cheaper to build and more convenient. Arranging several short rows of stanchions across the width of the barn requires more labor in doing chores. This plan requires a width of 40 feet or more to house the same number of cows for a given length of floor as the two row arrangement with a width of 36 feet. A barn 40 or more feet wide requires heavy roof framing and is therefore more costly. The labor of mowing away the hay is also much greater in a wide barn. Most dairymen favor the two row arrangement.

SHALL COWS FACE IN OR OUT?

Whether it is better to face cows from or toward a center aisle is an open question. Good arguments can be made in favor of either arrangement. One of the chief reasons for having the herd face the center aisle is that this arrangement provides a central feeding alley. It is more convenient, of course, to feed from one alley, especially if feeding ensilage. Careful feeding is necessary to successful dairying and as cattle are fed two or three times a day this point deserves attention. When the cows are faced in there is no danger of the direct sunlight affecting the cow's eyes. This plan places the milkers nearest the light so they can see that the cow's udders are clean. Cleaning out the manure is as easy, if a litter carrier is provided, as driving through the barn between the two rows of cows. A feed carrier, running between the two rows of cattle, can be used to carry feed to various parts of the barn.

The advantages of having the cattle face out are: (1) cattle do not spatter the outside wall with manure as they do when facing the center aisle; (2) a manure spreader can be loaded in the barn and hauled directly to the field, thereby saving handling the manure twice; (3) sale cattle can be shown to better advantage when facing out from the center; (4) it is easier to get cows in and out of the barn with less danger of crowding; (5) it is more convenient for the use of the milking machine; and (6) it is more sanitary because cows facing each other in a central feeding alley can transmit diseases readily by coughing and sneezing.

STALL FLOORS SHOULD BE SANITARY

Wood and earth floors are insanitary. A good concrete floor, insulated by a layer of cinders underneath and well bedded or provided with an overlay, is best. Concrete floors finished with a wooden float are not slippery. If wooden overlays are used treat all 2 x 4 to be bedded in the concrete floor with creosote, or leave grooves in the floor with bolts embedded, in order to replace the 2 x 4 as they rot. Cork brick and creosote wood blocks are excellent materials for overlays on stall floors. Such floors are sanitary, less slippery, last longer, and are easier to keep clean than a wooden overlay.

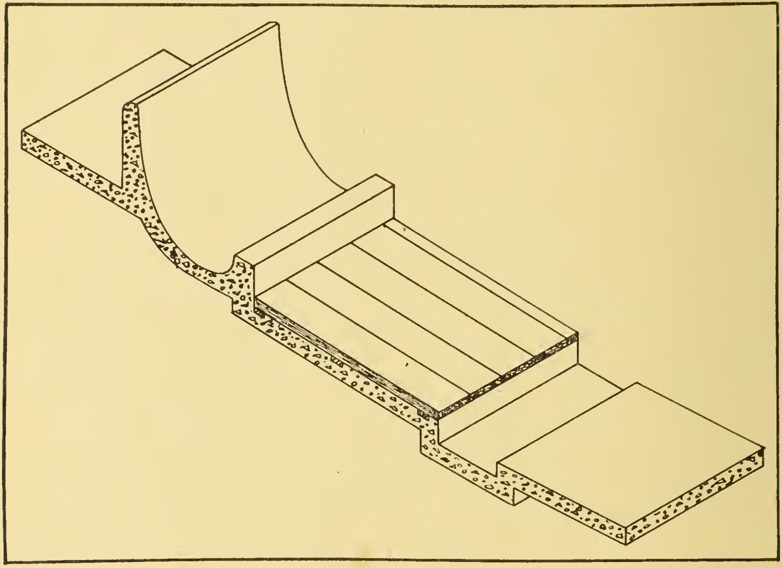
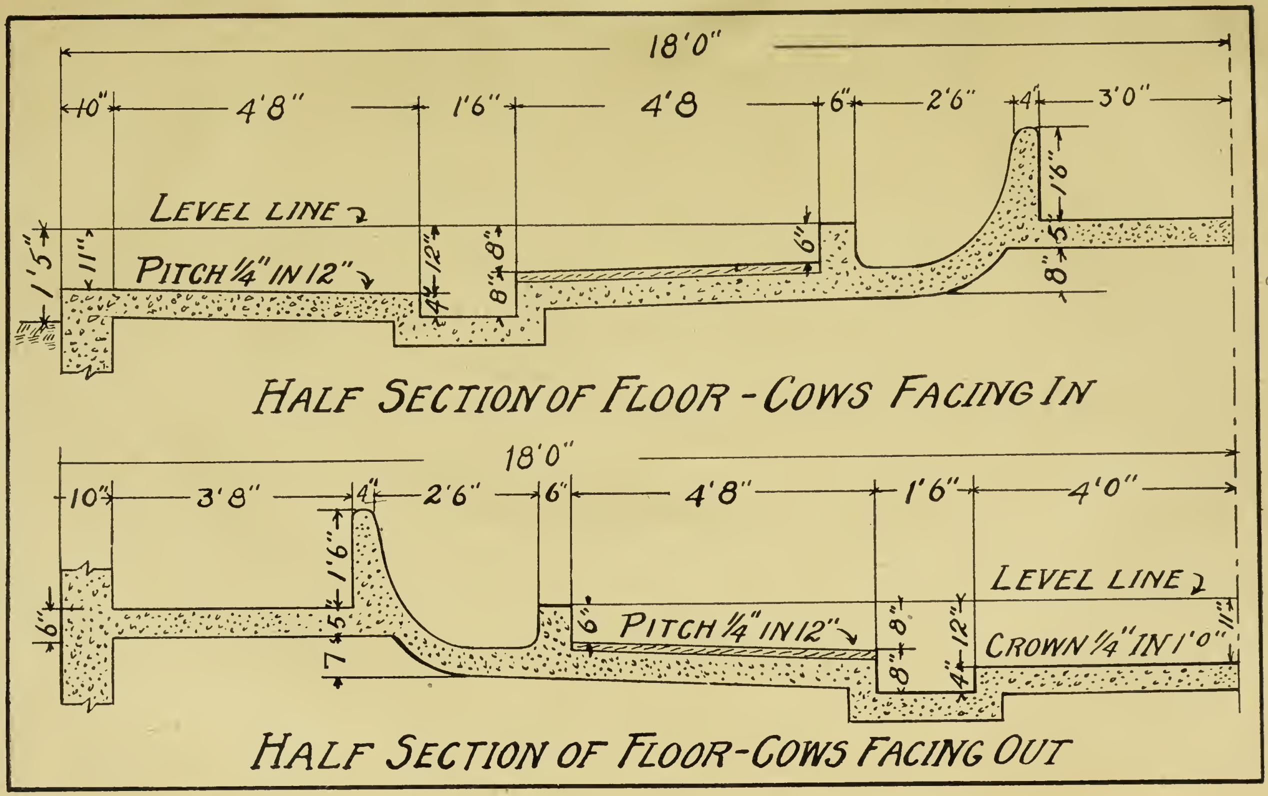


FIG. 13.—A WOOD OVERLAY.

Wood overlays on concrete floor can be kept sanitary and may be replaced with little difficulty.

A stall floor 4′ 6″ to 5′ 0″ long not including manger or gutter is required. Large Holsteins require 4′ 10″ to 5′ 0″,



HALF SECTION OF FLOOR - COWS FACING IN

HALF SECTION OF FLOOR - COWS FACING OUT

FIG. 14.—THE COW STALL FLOOR SHOULD BE CAREFULLY PLANNED.

It is important to have the feeding alley, the manger, the stall platform, the gutter, and the litter alley or driveway of proper dimensions.

while for a Jersey or Guernsey a length of 4′ 6″ to 4′ 9″ may be ample. If the cows are not of nearly uniform size, the stalls may be built 4′ 6″ long at one end of a row of stanchions and increased to 5′ 0″ at the other end. The cows may then be arranged in the barn according to size. A width of 3′ 4″ is sufficient for small cows but large cows require 3′ 8″. Figure 14 suggests dimensions for gutter, manger, feed and litter aisles.

STABLE WALLS SHOULD BE WARM AND DRY

Satisfactory stable walls have been built from a variety of materials. The walls should be smooth in order to be easily kept clean. Warmth is important in the economy of feeding. The walls should be so insulated that there will be no gathering of frost on them. Lumber walls built with several thicknesses of sheathing and tar paper and provided with an air space, are good. Certain kinds of hollow building tile make a good wall. Stone masonry walls when built thick are warm, but they are not easy to keep clean because of roughness. Concrete has been widely used and will, undoubtedly, be used in the future. A solid concrete wall, however, is cold and becomes covered with frost on the inside during cold weather. This may be remedied to a large extent by a double wall with an air space between. Headers of concrete or metal, however, should not be used to bind the two walls together because they are conductors for the cold and reduce the value of the air space. A solid concrete wall may be made warm and dry by fastening furring strips an inch or more in thickness on the inside and covering them with tar paper and sheathing or with insulating board. The furring strips are nailed to 2″ x 2″ bedded in the concrete.

Storm windows and double doors make barns extra warm. The extra doors are usually hung on the inside of the building. When inconvenient to hinge them at the sides, the hinges can be placed at the upper end. The doors are then opened by swinging them toward the ceiling where they can be held by hooks. Weights and pulleys and other ingenious devices can be used to reduce the work of opening the door.

GAMBREL AND GOTHIC ROOFS PROVIDE MORE MOW SPACE

Gambrel or Gothic roofs provide more mow space, are self-supporting, and require no interior posts or beams if built according to the Gothic type, (Fig. 16) the plank frame, or the braced rafter (Fig. 1) method. The heavy timber type of framing is seldom used now except in pioneer communities, because it requires a large quantity of expensive timber. The construction suggested by figure 1 takes much less lumber and labor and is strong and rigid enough if built according to standard designs.

The mow should provide space to store more than one year's requirement of roughage, as many farmers desire to carry over considerable feed. The capacity may be computed by making an allowance of 12 pounds of hay a cow a day for the feeding season. A ton occupies about 512 cubic feet.

A common rule to determine the rise and run of rafters for a gambrel roof is shown in Figure 15. The run of the lower rafter is to equal to one sixth the total span of the roof measured from the outside of each wall. The rise of the lower rafter should be twice its run. The rise of the upper rafter should equal the run of the lower rafter, and the run of the upper rafter is equal to the rise of the lower rafter.

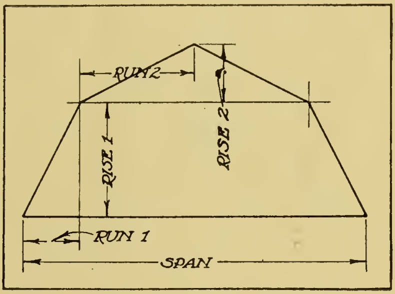


FIG. 15.—PROPORTIONS COMMONLY USED IN RAFTERS OF GAMBREL ROOFS.

Run 1=⅙ Span; Rise 1=2 times Run 1: Run 2=Rise 1; Rise 2=Run 1.

Barn builders have recently developed the Gothic roof barn in an effort to secure even more storage room than is possible in the gambrel roof. These barns have been built in large numbers in sections of Minnesota and the Dakotas, and a few have been built in Michigan, Iowa and Wisconsin.

Two methods of building the circular rafters are advocated. In one, all of the rafters are built of four thicknesses of 1 inch by 4 inch material bent to shape and nailed or bolted together. These rafters are spaced about two feet apart and the roof boards nailed to them in the usual way. The other method is shown in the detail in Figure 16. Heavy rafters spaced 8 or 10 feet apart are built of four thicknesses of 2″ plank or 6 thicknesses of 1″ boards cut to shape and nailed and bolted together.

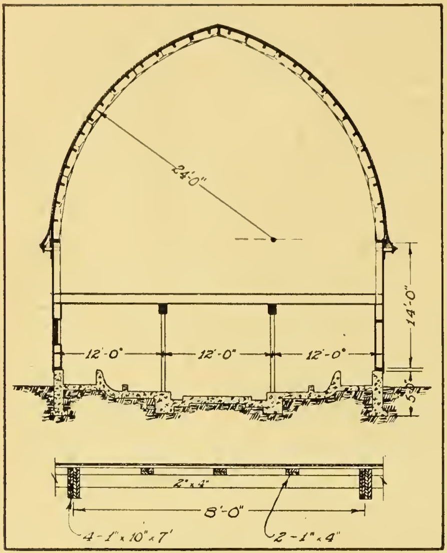


FIG. 16.—GOTHIC TYPE BARN

These roofs are gaining in popularity

2″ x 4″ similar to the nailing girts are fastened between these rafters. Two thicknesses of 1″ x 4″ lumber spaced 2 feet apart are nailed to these girts parallel to the big rafters, and the roof boards are nailed to both the light and the heavy rafters. The rafters have the shape of an arc of a circle, with the center on a straight line between the plates and the radius between three-fifths and two-thirds of the total width of the barn. If a shorter radius is used the roof will not hold its shape well near the ridge. It appears, in fact, that a radius as long as three-fourths of the width would be desirable because a roof with a steeper slope could maintain its shape better.

In the Gothic barn there is no interior bracing, except that at points where the heavy rafters are located a 2″ x 12″ plank is placed just inside the studs and plate, and bolted both to the rafters and floor joists. This bracing is perhaps enough if the plate is not much over 6 feet above the floor joists. If the height

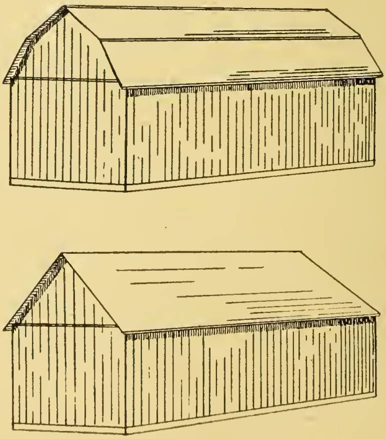


FIG. 17.—GAMBREL AND GABLE ROOFS.

The hay mow is increased in size in a gambrel roof barn without increasing the height of the roof at the plate or ridge.

is much greater, diagonal braces from the rafter at the plate to the floor joists at the girders should be put at the points where the heavy rafters are placed.

The end brace (Fig. 18) adds rigidity and strength to the barn frame. This brace requires little material and is easily put into place. Every barn of considerable size with either plank frame, or braced rafter, or Gothic roof construction should be built with two such braces at each end.

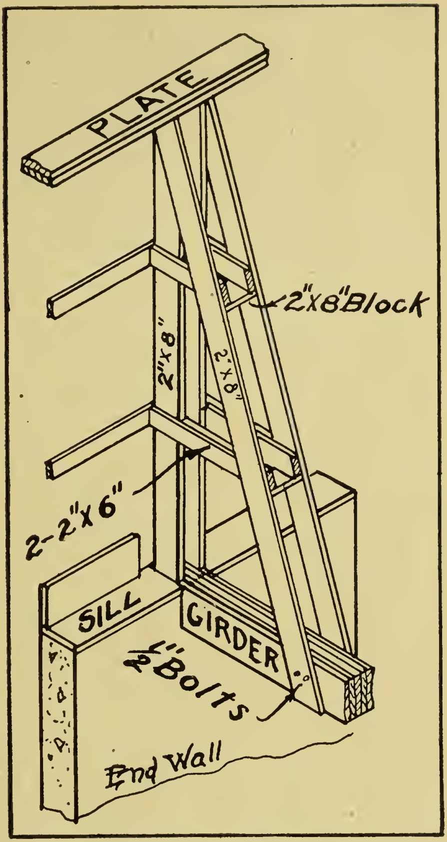


FIG. 18.—END BRACES ADD STRENGTH.

End braces prevent the end walls from bulging and add the rigidity necessary to withstand severe wind storms.

THE SETTLER'S BARN

The pioneer farmer in upper Wisconsin needs a different type of barn than does the owner of an improved farm. The fire hazard is often great and the amount of feed raised the first few years is limited. It would, therefore, be unwise to advise having large or expensive farm buildings at the start. Where capital is limited it can be put to better use in the clearing of more land. A barn large enough for two cows, a sow, some sheep and possibly a team will be adequate for the first few years. A one-story building with the roughage stacked outside is the usual arrangement. On new farms where enough feed can be raised to keep a team and four or more cows, and more capital is available, the settler might well build a larger and more permanent barn. This barn should be planned to permit enlargement when it becomes possible to increase the herd. The settler should use the materials at hand for his building. Timber is usually available and hewn lumber, or that sawed in a small local saw mill, can be used largely for the frame of the buildings. This reduces the cash requirement.

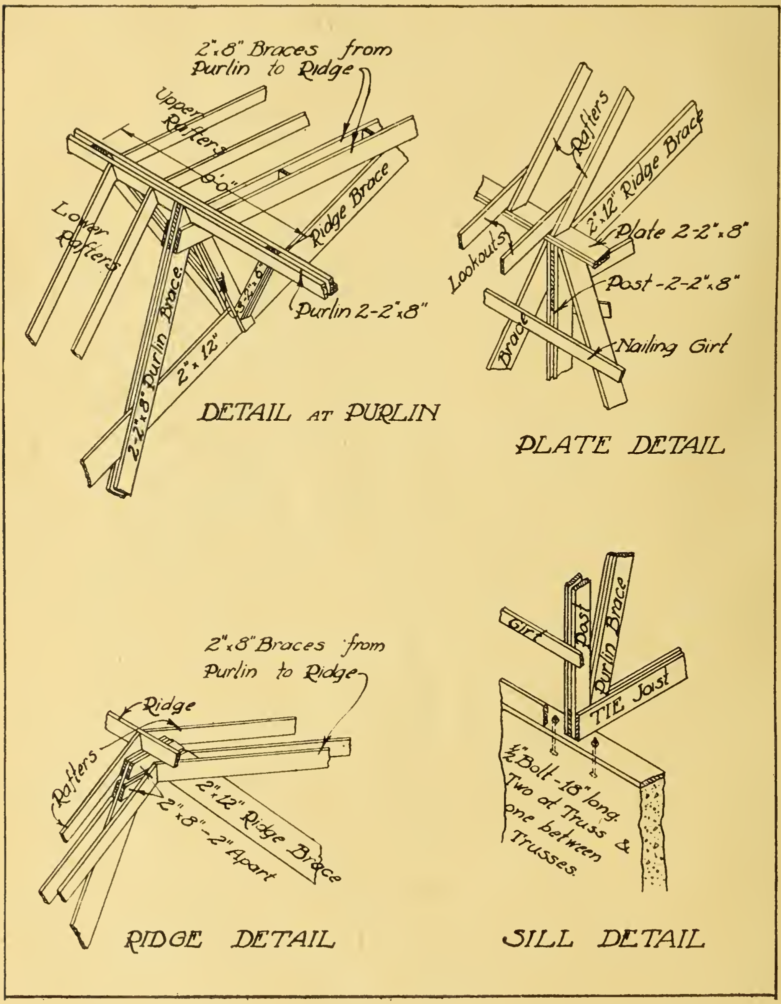


FIG. 19.—DETAILS OF CONSTRUCTION IN PLANK TRUSS FRAME

In Figures 20 and 21 are shown the plan and perspective of a

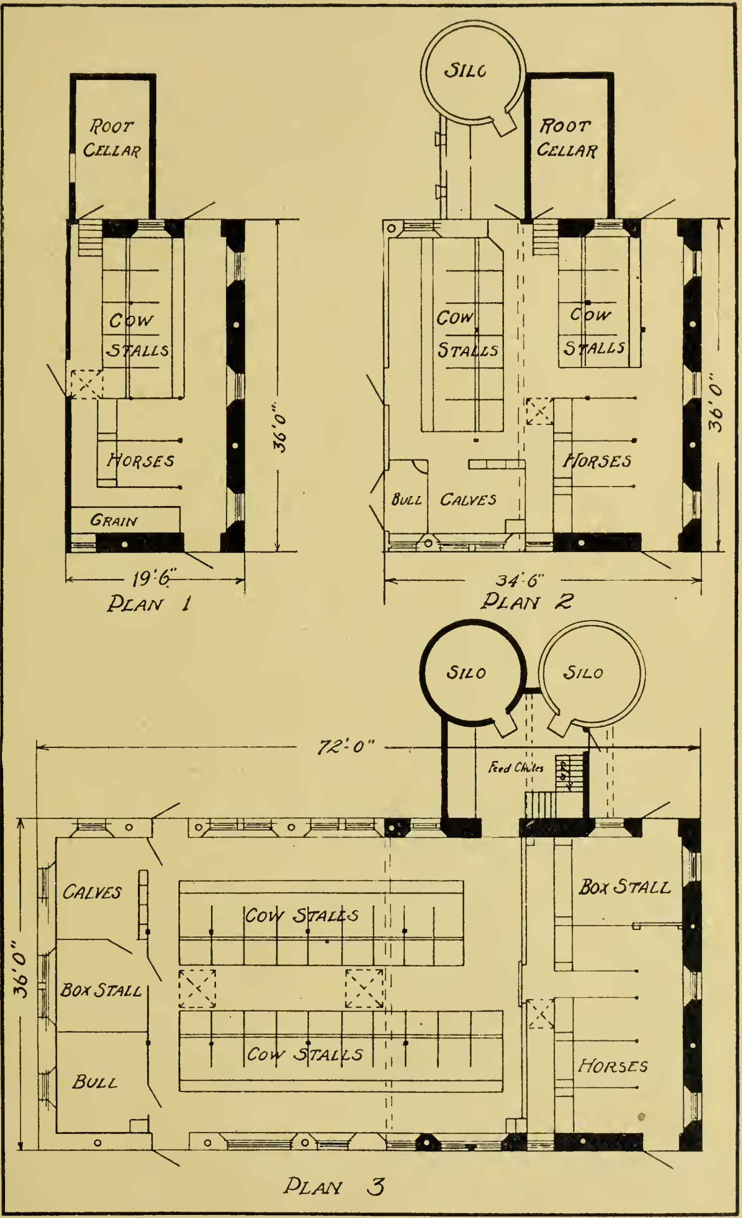


FIG. 20.—PLAN OF PIONEER BARN.

Plan 1 is built when the farm is capable of supporting only a very limited amount of stock. This is added to in Plan 2 and finally completed as shown in Plan 3.

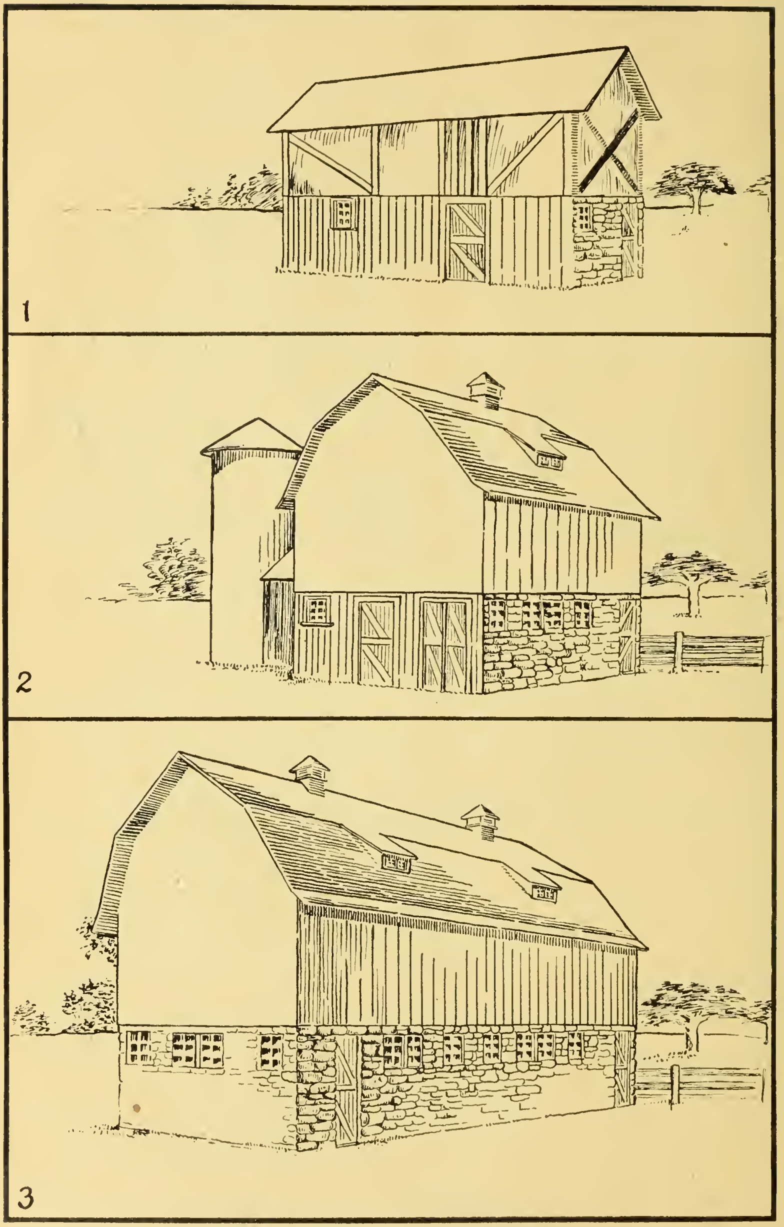


FIG. 21.—PERSPECTIVE OF PIONEER BARN, PLANS OF WHICH ARE SHOWN IN FIG. 20

pioneer barn. This can be built in sections as the requirements demand, without making expensive changes on the older portion. The farmer may wish to use a different plan, but a study of the building suggested will help him in making his own. Three sides of the stable wall in the first structure are built to serve as parts of the permanent barn. The top structure is merely a temporary roof to protect the roughage. The root cellar is provided to store succulent feed for the stock. As the need for barn room increases, the permanent walls of the sides of the barn are increased in length and a permanent superstructure is erected. The herd is now large enough to justify a silo. The next enlargement gives the barn its final shape and size. If necessary, a second silo may be built at this time.

REMODELING THE OLD BARN

On many farms are well constructed barns capable of giving years of service, but not built and equipped according to present ideas. It is commonly known that the two-row arrangement is most desirable for convenience and economy of space. Therefore, in the remodeling of a stable, an effort should be made to follow this standardized form. Barns 34 to 36 feet wide present no more difficult problems than the planning of the interior arrangement of a new barn.

A common defect of the old barns is that they were built too narrow to house two rows of stock comfortably and still leave alley room enough to do the chores with advantage. Arranging the cows in short rows across the barn is only a poor solution because with this arrangement extra time and labor are required in doing the chores. The manager of a large farm in Wisconsin has remodeled a number of such barns very satisfactorily. Figure 22 represents in section such a remodeled barn. One side wall of the old stable 30 feet wide is removed and the superstructure held by posts placed under the sill 6 to 10 feet apart. A lean-to is built on this side of the barn to bring the stable up to the desired width. The roof of this addition is made rather flat to give wall room enough for windows. Tarred felt roofing is used to make the flat roof leak-proof. The rafters may be covered on the inside with tar paper and sheathing to give added warmth. The interior of the barn is then arranged in the usual way and posts to support the ceiling are placed where needed and convenient.

Another adaptation of this same idea is shown in the lower section of Figure 22. Here the old barn is wide enough to permit the two row arrangement, but there is not room enough in the barn for the calves and young stock. It is not desirable to house the calves in a separate barn both because of the inconvenience of doing the chores and because the calves alone will not keep the barn warm in the winter time.

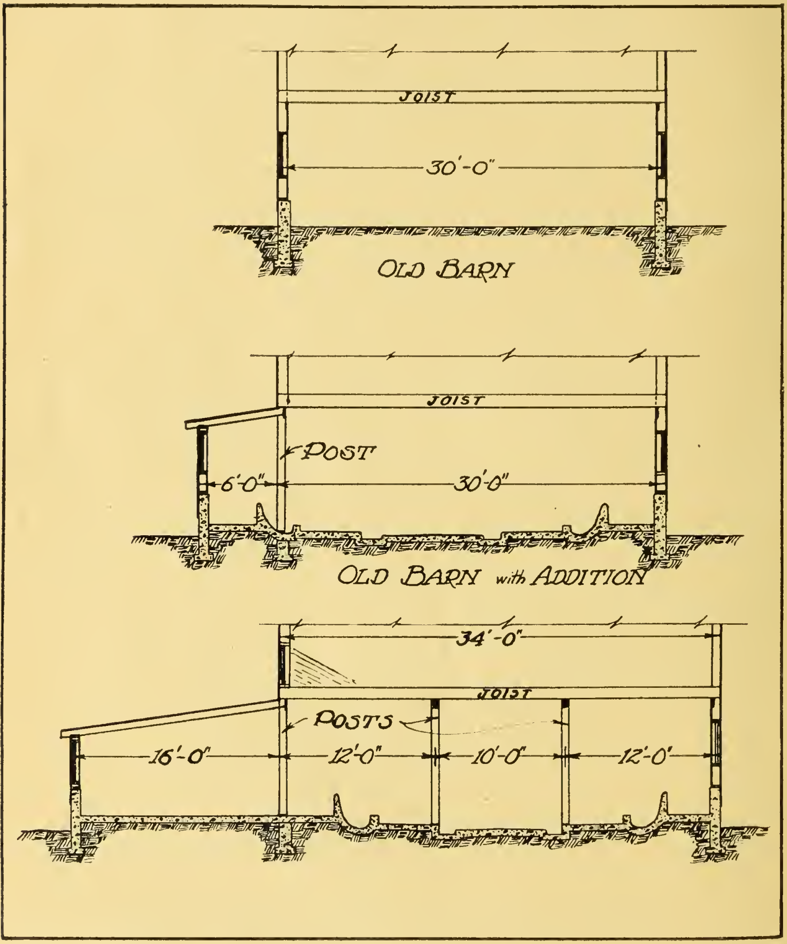


FIG. 22.—A WAY TO INCREASE THE STABLE ROOM WHEN REMODELING A BARN.

The building of this addition is like that described above except that windows are placed in the frame work above the sill. The light from this window enters the stable through a three-cornered chute built through the haymow. This can be made of double boards with paper between to give warmth, and painted white on the inside to reflect the sunlight. Not quite so much use can be made of the direct sunlight, of course, as one might wish but the lighting is good. Calf pens are placed in the additional space when convenient.

Some farmers may object to the plan because additional loft space is not given. It must be remembered that most of these old barns were built before the days of the silo, and loft space was provided to store sufficient hay to carry the stock through the winter. By the use of the silo the mow space needed is reduced; and the factor limiting the amount of stock carried on a farm is usually lack of stable and not lack of mow room.

A Manure Pit Saves Fertilizer

While many farmers recommend hauling the manure to the fields daily, this is not always practicable. At times the ground may be too soft to use a manure spreader; or again rush work which must be done in due season might be delayed in order to haul out the manure. Manure can be hauled when other work is slack and most farmers must plan on storing at least part of the manure.

The value of manure when compared with the present price of commercial fertilizers is around $5 a ton. A few weeks of leaching will reduce its value to $2.50 a ton or less. The farmer who piles 20 tons of manure on the ground in a corner of the barnyard and allows it to leach for several weeks, loses plant food equivalent to about $50. A concrete manure pit prevents this loss, improves the appearance of the barnyard, and keeps it clean and dry enough so that manure may be hauled out to the fields at any time. If not covered with a roof it receives as much rain as an open pile.

Placing The Silo

The location of the silo will affect the barn plan. Many silos are built outside the barn wall, leaving the entire area of the barn floor for stable. The silo belongs at the end of the feed alley so that feeding from the silo will require carrying the feed only a short distance. A chute 2 to 3 feet square is usually provided for throwing down silage. If the herd is large, much labor can be saved if a hopper large enough to hold a day's supply of silage is built at the bottom of the chute for receiving the silage. From this hopper the silage can be dumped directly into the cart and thus save shoveling. A feed room is often built between the barn and silo. Since dairy cows are fed considerable amounts of concentrates, this room should be large enough to hold at least a wagon load at one time. If no other convenient place is available for storing a reserve, such as a carload or a season's supply, this space should be provided in the feed room. If a driveway is provided on the barn floor above, this large storage space and bins are put there, the grain can be delivered by gravity to small boxes in the feed room below by means of chutes. Feeding the silage and concentrates from the same room saves time in feeding.

THE MILK HOUSE NOT A PART OF THE BARN

The room in which milk is to be handled should not be enclosed within the walls that form the stable. This means that the milk house need not be planned nor constructed when the barn is built. It is desirable, nevertheless, to plan the doors of the barn so that a milk house can be built either as an addition or as a separate building conveniently located for receiving milk from the barn.

MAKING GOOD CONCRETE

In many parts of Wisconsin good sand and gravel are available on the farm or nearby. Then the farmer can build permanent structures of concrete at a low cost. Concrete is best adapted to the building of foundations, barn walls, floors, manure pits, silos, root cellars, and storage tanks. The making of good concrete requires clean, coarse sand and clean, well-graded gravel as well as thorough mixing, and the use of the correct amount of water and cement. Nearly every failure of rural concrete construction is due to carelessness or ignorance of these simple requirements. To test the sand for foreign matter fill a two quart fruit jar with sand to a point 5 inches above the bottom. Fill with water to about two-thirds or three-fourths the height of the jar. Shake the contents well and allow them to settle. The silt or clay in the sand will accumulate as a layer on top of the sand. If this layer of silt is more than ¼ inch thick the sand should not be used because it will make a weak concrete. Coarse sand makes a stronger concrete than fine sand. If the latter only is available more cement will be needed to make a strong concrete. Screened gravel from the pit will usually be well graded. Crushed stone screened to a uniform size requires from 5 to 10 per cent more sand and cement than a sample containing various sizes.

Too much water reduces the strength of concrete. A sloppy mix produces concrete of only 50 per cent to 75 per cent the strength of a quaky mix assuming that equal amounts of cement are used in each. Make the concrete of such consistency that it will stand of its own weight and quake like jelly when patted with a shovel. Such a mixture is placed in forms easily, requires little tamping, and produces a strong concrete if sufficient cement is used.

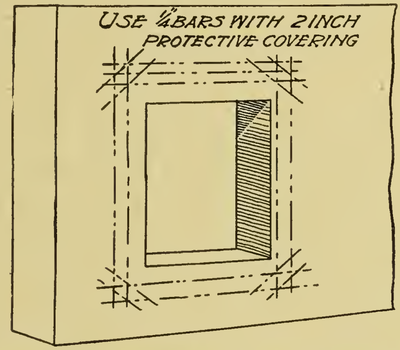


FIG. 23.—OPENINGS WELL REINFORCED

The rods are put in place as the concrete is poured.

The ratio of cement to sand and gravel depends on the use to which the concrete is to be put. Reinforced concrete requires a 1–2–4 mix,—one part by volume of cement, two parts of sand and four parts of pebbles or crushed stone. A wall or the lower course of a floor is usually built with a 1–2½–5 mix, while a 1–3–6 mix may be used for footings and heavy foundations. Silos or tanks for water storage must be reinforced to prevent the wall from cracking. Openings in walls should be reinforced along the sides of the opening and across the corners (Fig. 23) to prevent cracking. Whenever water tightness is desired, use a 1–2–4 mix, or even richer. Mixes containing less cement than a 1–3–6 ratio are often used, but a weak concrete results so that their use should be discouraged.

PIT GRAVEL SHOULD BE SCREENED

Sand and pebbles in pit run gravel are seldom found in the correct proportion for concrete work. Usually, twice the desired amount of sand is present. Since the strength of concrete varies as the ratio of the cement to sand, it is evident that for a given strength, a cubic yard of concrete made from pit-run gravel must contain more cement than a cubic yard of concrete made from sand and pebbles mixed in the correct proportion.

The saving of cement that can be made by screening the gravel usually more than pays for the extra labor involved. Where pit-run gravel is used in place of sand and pebbles, the following substitutions are often recommended: Five parts of pit-run to one part of cement for a 1–3–6 mix: 4¼ parts of pit-run to one part of cement for a 1–2½–5 mix: and 3½ parts of pit-run to one part of cement for a 1–2–4 mix.

A smooth surface may be obtained on the side of the wall by spading along the form as the concrete is placed. This forces the coarser particles toward the center of the wall and allows the finer particles to form a smooth surface at the form. A concrete barn wall is usually built 12 inches thick, a silo wall 6 inches, and walls of small farm structures 8 inches. Concrete walls less than 8 inches should be reinforced.

Bonding a layer of concrete to one previously poured requires certain precautions in order to obtain a water-tight joint. The old surface should not be smoothed with a trowel but should be left rough. Before placing the new concrete, thoroughly clean and wet the old concrete and cover it with a coat of cement without sand or pebbles and mixed with enough water to be easily applied with a trowel. Sharp pebbles or iron rods projecting from the old concrete into the new also aid in bonding the two surfaces.

New concrete poured in hot weather should be kept covered with moist straw or earth for a week or two, and wet once a day during this period. Concrete construction in freezing weather is poor practice unless the work is in charge of some one familiar with the precautions necessary under these conditions.

RODS PROTECT AGAINST LIGHTNING

Lightning rods protect farm buildings. Statistics compiled by insurance companies show that properly rodded buildings are practically safe from damage by lightning. A lightning rod system, however, is of little value, unless properly installed. This work should be directed by an experienced workman and several factors carefully considered.

Ground connections should be put down to permanent moisture in a hole about 10 feet deep and filled with earth. If this is impossible because of rock near the surface, the cable may be fastened to a copper plate and the plate buried as deeply as possible. It is well in this case to surround the plate with a bed of charcoal as this tends to retain moisture and provide a moist ground connection.

A shallow ground or loose cable connection makes many lightning rods worthless. These defects are hard to detect except while the work is being done. The hole in which the grounds are buried should not be filled until a good connection is certain.

All cables should be in a continuous circuit. A cable attached to the ridge will connect all points along the ridge to a ground at either end. The number of cables that should be grounded depends on the shape of the building. An oblong building requires at least two; an L- or T-shaped building three; and a U-shaped building four. The cable is fastened to the building by metal staples or clips. All metal parts of the building such as gutters, downspouts, water and gas pipes, hay and other carrier tracks should be connected to the cables or grounded at two points. In making all connections avoid sharp turns so as to prevent side flashes. Copper, aluminum or iron cable of 3, 2½, or 5 ounces to the foot respectively, may be used. Iron is the least desirable of the three, unless heavily galvanized, because it corrodes rapidly.

Points should be placed near the ends of the building, at each cupola and chimney and at intervals not greater than 20 feet along the ridge. Each point should extend from 3 to 5 feet above the ridge of the roof with its base firmly attached to the cable. The shape of the point is not important but is must be sharp.

AVAILABLE BUILDING PLANS

Plans and bills of material for barns and other farm buildings may be secured from the Department of Agricultural Engineering of the University of Wisconsin, Madison.

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